

wave in western Colorado, northeastern Arizona, and southeastern Utah were also distributed on the morning of the 20th. Snows occurred in the region mentioned, with a cold wave in southern Utah and extreme eastern New Mexico. The required fall in temperature, however, failed to occur in western Colorado, north-central and northwestern New Mexico, and northeastern Arizona, as the low which was over western Colorado decreased slowly in intensity and finally disappeared over New Mexico on the morning of the 23d. Warning of a moderate cold wave in eastern Montana, issued on the evening of the 29th, was verified in the extreme eastern portion of the State.

Local cold waves without warning occurred on the 13th at Lander; on the 20th and 25th at Havre, and on the 31st at Miles City. More general cold waves without warning occurred in eastern Montana on the 17th, and in southern and western Montana and eastern Wyoming on the 21st, due to the unexpected development of highs along the northwestern border. In the latter instance the temperatures throughout about all of that region were already severely low on the morning of the 20th.

Warnings of strong southerly to westerly winds in eastern Colorado and Wyoming were issued on the evening of the 6th for the benefit of aviation interests. A warning of strong westerly winds in the same region was furnished to these interests on the evening of the 28th. Both warnings were fully verified.—*J. M. Sherier.*

SAN FRANCISCO FORECAST DISTRICT

The month opened with a disturbance of marked intensity central over the Gulf of Alaska, in which the minimum pressure was below 28.50 inches. This disturbance moved east-northeast and caused rains over the north and central portions of this forecast district and southerly gales along the Washington-Oregon coast, for which storm warnings were issued the morning of the 1st. The highest wind velocity reported during the prevalence of this disturbance was 76 miles an hour from the south at North Head, Washington. This disturbance was the first of a number to move eastward over the northeast Pacific Ocean and give rains over the north and central parts of this forecast district and high winds on the coast. On 15 days of the month storm warnings were ordered for some part of the coast, principally the coast north of Cape Mendocino, but on the 9th, 10th, 14th, and 19th, storm warnings were displayed on the north part of the California coast. The record shows that six well-defined disturbances crossed the coast line during the month.

Beginning on the 11th and continuing through the 19th rains and snows became general over the Pacific Northwestern States and following the series of disturbances that passed over this area the barometer rose rapidly, the wind became north and northeastward, and the coldest weather of the winter overspread Washington, Oregon, Idaho, and Nevada during the 20th to 24th. This cold wave was attended by temperatures below zero over the eastern parts of Washington and Oregon and over Idaho and northern Nevada. Except in Idaho and northern Nevada, for which cold wave warnings were ordered, the fall in temperature was not sufficient to verify cold-wave warnings. Nevertheless, cold-weather forecasts were issued for all of these States well in advance of the occurrence of the cold weather. Advancing southward the cold wave was greatly modified, but it brought freezing temperature or frosts to nearly all parts of California and necessitated the issue of frost warnings for the benefit of fruit growers and others.

On the 26th when the pressure was low and falling rapidly over the Gulf of Alaska storm warnings were displayed on the Washington-Oregon coast and were repeated on the 27th for the inland waters of Washington. This was a pronounced disturbance and was attended by general rains except in southern California and southern Nevada. The highest wind velocities of the month were recorded at northern stations during this storm, maximum 80 miles an hour from the south at North Head, Wash., on the 27th.) On the 31st, when a disturbance was detected far to the westward, southeast storm warnings were ordered for the Washington-Oregon coast. This disturbance moved eastward, causing general rains and snows over the northern half of the forecast district and southerly gales along the north coast.—*E. H. Bowie.*

RIVERS AND FLOODS

By H. C. FRANKENFIELD

Tennessee River.—As was stated in the MONTHLY WEATHER REVIEW for December, 1926, the flood in the Tennessee River had just about reached Decatur, Ala., by the end of that month. The rise began with the heavy rains of December 20-21, and the still heavier rains of December 23-25 soon carried the stream to flood stage. Above Chattanooga, Tenn., the crest stages were only a foot or two above the flood stages, although some of the tributaries, notably the Clinch River and the North Fork of the Holston River, were relatively much higher. The moderate flood at Knoxville, Tenn., came mainly from the Holston River drainage. The average rainfall below Chattanooga from December 20 to 29 was a little less than 9 inches and the flood was a severe one, with crest stages ranging from 4.3 feet above the flood stages at Bridgeport, Ala., to 17 feet above at Riverton, Ala.

The usual warnings were issued well in advance of the flood and frequent supplementary advices during its progress, although over the middle and lower river the distribution of the latter, as well as the receipt of reports, was much hampered by ice on wires and local interruptions due to the holiday season. Direct losses above Decatur, Ala., were about \$60,000, mainly in corn in river bottoms which for some reason was not removed when the warnings were issued. In the city of Chattanooga about 2,500 persons were out of their homes at the height of the flood, and some relief measures were necessary. Below Decatur reported losses were \$360,000, of which \$269,950 was in matured crops, while the reported value of property saved through the warnings was \$192,000.

Green River of Kentucky.—The flood in the Green and Big Barren Rivers was likewise severe. Preliminary warnings were issued on December 21, or as soon as the first reports of heavy rain were received, and frequently thereafter. The highest water reported was 49.3 feet, 16.3 feet above the flood stage, on December 27, at Lock No. 4, Woodbury, Ky. Reports as to losses and damage were so conflicting as to be worthless. They were of the usual character, but probably least in crop losses owing to the time of the year.

Ohio River.—During the December-January period the Ohio River was in flood only from Dam No. 44, Leavenworth, Ind., to its mouth, and only moderately so above the mouth of Green River. The crest passed Cairo, Ill., into the Mississippi River on January 12 with a stage of 48.9 feet, 3.9 feet above flood stage. While the warnings issued were timely and accurate, the losses in matured crops were great. The flood was the earliest winter flood of consequence of which there is record, and long periods of wet weather during the

autumn had delayed the gathering of crops, especially of corn. The reported losses aggregated \$379,765, of which \$316,150 was in matured crops, while the value of property saved through the warnings was \$293,500. The following comment on this flood by Mr. W. E. Barron, meteorologist in charge of the Weather Bureau office at Cairo, Ill., is of interest:

This flood showed some quite remarkable features. In the first place, there was no flood in the Mississippi River above Cairo nor along the upper and middle stretches of the Ohio, while the Cumberland River broke all previous records, and the Tennessee from Florence, Ala., to near the mouth was the highest since 1897. Second, the rate of crest movement was unusually slow, Cincinnati to Shawneetown 6 days, Cincinnati and Chattanooga to Paducah 8 days and to Cairo 9 days. This is attributed to the vast body of water ponded in the Cumberland Valley, the crest at Eddyville, Ky., 68.5 feet, 12.5 feet above flood stage, occurring only 1 day before the crest at Paducah. The flood from the Cumberland undoubtedly added materially to the stage at Shawneetown, Ill. Backwater effects were also noted in the Mississippi at Cape Girardeau, Mo., 50 miles above the mouth of the Ohio, with a slow steady rise from December 30 to January 7 amounting to 3.2 feet, with no rise upstream.

Lower Mississippi River.—The Mississippi River reached the flood stage of 34 feet at New Madrid, Mo., on January 1, and the flood stage of 45 feet at Vicksburg, Miss., on January 16. Flood stage at Greenville, Miss., was not quite reached, and the river below Vicksburg was not in flood during this rise. However, relatively high stages prevailed throughout the month, with the second and greater flood in progress at the close of the month. The crest stage at Memphis, Tenn., was 37.7 feet, 2.7 feet above flood stage, on January 12, and approximately 35,000 acres of land in the Memphis district were overflowed. Losses were unusually large for a flood of this character, mainly from unpicker cotton, a large quantity of which had been left in the fields awaiting improved market conditions. The reported losses aggregated \$774,100, of which \$405,800 was in matured crops. The reported value of property saved through the warnings was \$275,000.

The Yazoo River was in flood throughout the month, with a crest of 30.4 feet, 5.4 feet above the flood stage, at Yazoo City, Miss., on January 21.

The December-January flood in the Tombigbee River.—This flood was also severe, except in the upper Tombigbee, with crests of 65.3 feet, 26.3 feet above flood stage, at Demopolis, Ala., on January 5, and 61.8 feet, 15.8 feet above flood stage, at Tuscaloosa, Ala., on the Black Warrior River, on December 26. Lowlands along the river and tributaries for a distance of more than 500 miles were inundated, the overflowed area ranging in width from one-half mile to as much as 7 miles. Reports as to losses were very incomplete. One corporation reported:

We lost nothing. The individual losses no doubt would be great. Ample warning was given to save loss of life and most of the property. The information given was correct.

Total reported losses were \$94,500, and the value of property saved through the warnings \$129,000. Eight persons were drowned in the vicinity of Columbus, Miss. The flood was a distinct benefit to many lumbermen, as it permitted the floating out from swamp lands of about 20,000,000 feet of timber, the early warnings affording ample time for preparations for the work.

THE GENERAL OHIO RIVER FLOOD

Pittsburgh, Pa., to Wheeling, W. Va.—Contrary to the usual procedure, this flood was a slow one, mainly on account of a series of moderately heavy rains instead of a heavy continuous rain of a day or two, and the rain

effect was materially augmented by the prevailing high temperature that melted the accumulated snow and ice, and even took the frost out of the ground.

The first warning was issued at Pittsburgh on January 21, and as often thereafter as changing conditions required. The crest at Pittsburgh was 29.7 feet, 4.7 feet above flood stage, at 5 a. m. January 23, and at Wheeling, W. Va., 41.7 feet, 5.7 feet above flood stage, at 7 p. m. January 23.

While there was the usual inconvenience and the expense attached thereto, actual losses were very small, probably not exceeding \$10,000 for the entire district.

Wheeling, W. Va., to Parkersburg, W. Va.—Conditions were much the same as above, and the usual warnings were issued in ample time. Losses, however, were somewhat heavier, although not very large for a great flood, only about \$125,000 having been reported. The crest stage at Parkersburg was 45.5 feet, 9.5 feet above flood stage, at 9 p. m. January 24. Traffic of all kinds was delayed, and there was much loss of time in factories and shops.

Kanawha River to Kentucky River.—In this, the Cincinnati, Ohio, district, the unusual feature of the flood was the uneven distribution of the rainfall and of the rises in the tributary streams. With the exception of the Licking River, the southern tributaries in West Virginia and eastern Kentucky were generally low. The usual experiences of a great Ohio River flood were repeated, and warnings, bulletins, etc., were issued frequently and given the widest possible distribution by telegraph, telephone, radio, and the press. The crest stages were from about 4 to 8 feet above the flood stages, Cincinnati reporting 59.1 feet, or 7.1 feet above flood stage.

Again the losses were very small, and very little farmland was overflowed. The Central Union Railway Depot was vacated for 7 days, and a great deal of merchandise removed from warehouses. Reported losses were only \$63,000, while the value of property saved through the warnings was given as \$600,000.

Mouth of Kentucky River to Hawesville, Ky.—In this district the heaviest rains fell in the immediate Ohio Valley between Louisville and Cloverport, Ky., and over the lower Kentucky River Basin. This local distribution caused relatively higher stages in the district, resulting finally in a "flat" crest that extended from Madison, Ind., almost to Cloverport. Another interesting feature was a flood in the lower Kentucky River, while the upper river was only at moderate stage. This Kentucky River flood caused some inconvenience, but no loss of consequence. Neither were the losses along the Ohio River very serious. A considerable acreage of bottom lands was flooded, but the total of the reported losses was only \$90,530, while the value of property saved through the warnings was given as \$144,000.

In the Evansville, Ind., district the flood was still at its height, and the river was once more rising rapidly over the Cairo district. Report of this will be made later.

Northern tributaries of the Ohio.—The northern tributaries of the Ohio River were generally in flood, although none was serious. Warnings were issued when needed, and losses were not great. Within the State of Ohio the reported losses were \$187,000, while the warnings, according to estimates received from business interests, were the means of saving property valued at \$1,162,500.

The floods in the Wabash and White Rivers of Indiana were of the same general character as those in the State of Ohio, and the resulting damage was comparatively